FIRE DANGER OPERATING PROCEDURES, DECISION CLASSES, AND MANAGEMENT ACTIONS

Contents

OBJECTIVE(S)

Upon completion of this lesson, participants will be able to:

1. Determine which correlation of fuel model and NFDRS output is appropriate for a fire response plan (i.e., pre-planned dispatch, pre-attack plan, run cards).
2. Determine which correlation of fuel model and NFDRS output is appropriate for a staffing plan with 5 decision classes.
3. Determine which correlation of fuel model and NFDRS output is appropriate for communication with our internal agency personnel affecting weekly, monthly, or seasonal fire preparedness decisions.

NARRATIVE

I. INTRODUCTION

The National Fire Danger Rating System (NFDRS) can be described as a series of interrelated / interconnected models designed to produce values which – when applied in the appropriate context – have the potential to provide meaningful information to a decision-maker. The NFDRS models work collectively by assimilating data in a step-by-step procedure (algorithm) to generate one or more values; as needed, the generated values feed other models before producing the result. The NFDRS is a system of algorithms which are driven by computer processors. With respect to the NFDRS, there are two processors: FireFamilyPlus and WIMS. References will be made to both processors as we bridge the analysis phase of the FDOP to the operational aspects of fire danger rating applications.

A. FireFamilyPlus (FFP) – Historical Analysis Tool

FireFamilyPlus software offers a suite of analytical and planning tools which provide an objective way to evaluate the many combinations of fire danger indices for fire business decision support. As a stand-alone software application, FireFamilyPlus is an essential tool for analysis in the development of Fire Danger Operating Plans (FDOPs) by computing indexes and components of the National Fire Danger Rating System (NFDRS), and the Canadian Forest Fire Danger Rating System (CFFDR) from weather climatology data. FireFamilyPlus will provide the answers to questions related to analysis and planning (such as climatological breakpoints and fire business thresholds); however, it does not automatically import weather needed for NFDRS outputs, nor does it automatically import fire data for fire business analysis. FireFamilyPlus is supported by the Rocky Mountain Research Station, U.S. Forest Service (Missoula Fire Lab); more information is available at https://www.firelab.org/project/firefamilyplus

B. Weather Information Management System (WIMS) – Daily Operations Tool

The WIMS processor has been designed provide daily operational decision support. WIMS is a web-based application system that houses software for computing daily NFDRS fuel moistures and indices for a network of about 2,000 U.S. Remote Automated Weather Stations (RAWS). The WIMS combines the fire danger processor with a national fire weather database to provide graphical and tabular displays of recent, current, and forecasted fire danger. Like any other software or web-based application, there are administrative and technical elements which require training and experience to effectively implement WIMS in support of the Fire Danger Operating Plan. WIMS is supported by the Rocky Mountain Research Station, U.S. Forest

Service (Missoula Fire Lab); more information is available at https://www.firelab.org/project/weather-information-management-system

II. OPERATIONAL CONSIDERATIONS

The implementation of an effective interagency Fire Danger Operating Plan involves a team of professionals with the ability to apply their working knowledge, technical skills, and training to provide operational support. The analysis component of the FDOP is often the easy part; the biggest challenge may be the implementation of actions at pre-determined decision points.

At this juncture, it is important to consider a few of the operational elements of the FDOP intended to bridge actions to the analysis. The following elements should be included in the FDOP.

A. RAWS

1. PMS 426-3 (Interagency Wildland Fire Weather Station Standards & Guidelines)

a. Maintenance

RAWS need to receive annual maintenance as per PMS 426-3. In addition to annual maintenance, the FDOP should include plans for unexpected equipment failure or other issues which necessitate repair. RAWS annual maintenance, emergency repair, and site maintenance can be accomplished by contractual agreement with the Remote Sensing / Fire Weather Support Unit (RSFWSU) or agency personnel that have completed RSFWSU RAWS maintenance training. Additionally, it's important that the site is maintained to prevent encroachment of vegetation. Additional information regarding RSFWSU maintenance services, including service contract fees can be found at https://raws.nifc.gov/remote-sensing-fire-weather-support-unit-statement-services.

b. Weekly Noncompliance Report (https://raws.nifc.gov/standards-guidelines)

A weekly report from Wildland Fire Management Information (WFMI) weather module displays RAWS that are more than 1 year and 45 days past their annual maintenance date. Fire weather stations are to be maintained annually per Interagency *Wildland Fire Weather Station Standards and Guidelines (PMS 426-3)*. The report is widely distributed by email and available at https://famit.nwcg.gov/applications/RAWS. If a RAWS is on the report, it has either not had annual maintenance, or the documentation for annual maintenance has not been completed in WFMI. Data from these RAWS should not be used or used with caution.

c. Interagency RAWS Network

RAWS within any given analysis area may be purchased and/or owned by multiple agencies. Consideration should be given to the management of RAWS (especially those included in FDRAs) for the mutual benefit of all jurisdictions. The FDOP should account for the agency and owner of each RAWS for the purposes of coordination and weather station management.

B. WIMS

The following information is based upon an update to WIMS on June 8, 2018 (*refer to WIMS Technote-2018-01*).

1. Significant Changes

a. Fuel Models

NFDRS2016 models are now running in the background, using hourly observations from the existing RAWS network to generate a once-daily NFDR record (at the stations regularly scheduled (RS) time) for each new fuel model. This record type is being called type "N" and it supersedes existing type "N" records that have been being created existing fuel models. It will take about 30 days for the moisture models to calibrate to current weather. The fuel models have generic names and are derived from the established Fire Behavior Prediction System models. They are denoted by the prefix "16."

b. DIDX

There are now decimal places in the moisture and index values. A new line allowing you to select specific fuel models to display. From DIDX/DIDM you can select to display specific NFDRS2016 model rows via checkboxes in that line.

c. DIDM

The DIDM screen has new columns that track the daily GSI values that drive the live fuel moisture calculations.

d. ENFDR

ENFDR manages which models will be displayed in an initial DIDX/DIDM screen (requires edit station privileges).

e. COMP

The COMPARE screen is designed to allow you to compare outputs from two fuel models at one station. You do not need the Model Manager role to use COMPARE.

f. ENRR

A new type (2016 Indices Only) has been added.

2. Staffing Index Breakpoints

Enter the Staffing Index code for the fuel model upon which the user agency bases fire danger rating decisions. More than one index may be selected for use at a station, but each requires a complete line entry on the "Create Default NFDRS Parameters" form.

Valid entries are as follows:

a. **BI** BURNING INDEX Very high sensitivity to the fuel model. Low to moderate memory. Moderate variability. Low predictability. Fair to good characterization of the fire season.

b. EC ENERGY RELEASE COMPONENT Very high sensitivity to the fuel model. Moderate to good memory. Low variability as it is not affected by the wind. Good predictability. Fair to good characterization of the fire season.

c. IC IGNITION COMPONENT Moderate sensitivity to fuel models. Very short memory as it is dominated by the 1-hour time lag fuel moisture. Highly variable due to effects of relative humidity and wind speed. Very low predictability. Very poor characterization of the fire season.

d. SC SPREAD COMPONENT Very high sensitivity to fuel models. Very short memory dominated by surface area weighting and the 1-hour TLFM. High variability due to relative humidity, wind, and live fuel moisture. Low predictability. Very poor characterization of the fire season.

e. KB KEETCH-BYRAM DROUGHT INDEX No sensitivity to fuel models. Good memory, moderate variability, good predictability and characterization of the fire season. NFDRS Forecasts.

C. Forecasted Weather

Forecasted NFDRS weather is not yet available for NFDRS2016. Developers are working to use the existing 7-day National Weather Service fire weather forecasts. Currently, a NFDRS2016 forecast will be populated with -99.00 values.

D. Roles and Responsibilities

Defining a common understanding of the roles and responsibilities as it relates to the implementation of a Fire Danger Operating Plan (FDOP) will alleviate confusion and inefficiencies when the fire danger decision support is needed most. Minimally, consider the following positions with respect to their role in the planning and operations of the FDOP:

1. Agency Administrator

   Possible Roles/Responsibilities: The Agency Administrator has received delegation within their respective organization to make decisions which affect all agency lands within the dispatch unit.

2. Fire Program Manager

   Possible Roles/Responsibilities: With overall responsibility for the fire program, each agency employs a Fire Program Manager (or Fire Management Officer) with delegated decision authority. It is essential for the successful implementation of the FDOP and associate decision support that each Fire Program Manager – from each agency – become familiar with the relationship of the Land-Use Plan(s), Fire Management Plan(s), FDOP, and the Response, Staffing, Preparedness, and Prevention plans.

3. Dispatch/Communication Center

   Possible Roles/Responsibilities: The dispatcher has traditionally assumed the essential role to run the WIMS processor to obtain NFDRS indices/components. This position should be identified and targeted for WIMS and S-491 training.

4. Model Manager (WIMS)

   Possible Roles/Responsibilities: WIMS has added a new user role called Model Manager. Those assigned to this role will have additional tabs (in the ENFDR screen) to actively manage the live and dead fuel moisture models.

5. Station Owner (RAWS)

   Possible Roles/Responsibilities: The RAWS Station Owner is the entity who is responsible as a RAWS point of contact in the weather section of *Wildland Fire Information Management (WFMI)* and to ensure maintenance is documented as per policy. RAWS Station Owners have specific responsibilities as per *PMS-426-3*. This person may be different from the Station Owner listed in the WIMS Station Catalog (see below).

6. Station Owner (WIMS)

   Possible Roles/Responsibilities: The WIMS Station Owner is responsible for the data obtained from weather stations for both analytical and operational purposes. The WIMS Station Owner is identified in the WIMS Station Catalog and manages the Access Control List granting privileges to edit and view WIMS data. It is very important that WIMS Station Owners delegate the appropriate access to those who will need edit access, ensuring an appropriate level of backup for essential WIMS roles.

7. Duty Officer

   Possible Roles/Responsibilities: Identify the Duty Officer's role to implement the staffing, preparedness, or response plans. It is recommended to include the delegated responsibility to interpret and modify the daily staffing, preparedness and dispatch levels (if warranted) due to extenuating factors not addressed in the plan. Include that any modification of the staffing, preparedness and/or dispatch levels should be coordinated through the Fire Center Manager and/or FMO.

8. Education / Mitigation / Prevention Specialist

   Possible Roles/Responsibilities: Often overlooked, the fire education/mitigation specialist is a key to the tasks associated with public and industrial prevention programs.

9. Fire Danger Technical Group

   Possible Roles/Responsibilities: It can be advantageous to designate a group of interagency interdisciplinary specialists that can focus on the technical aspects of analysis, planning, and implementation of the FDOP. The tasks given this technical group can be identified in the Fire Danger Operating Plan.

10. Geographic Area Predictive Service / Meteorologist

    Possible Roles/Responsibilities: Each Geographic Area Coordination Center (GACC) employs meteorologists with responsibilities that include fire danger rating. Predictive Service Areas (PSA) were delineated using similar criteria as FDRAs; in some states, the PSAs are edge-matched to PSAs. However, the focus of PSA-based products is to support decisions for longer-range prediction purposes and strategic planning at the sub-geographic scale. For this reason, it becomes advantageous to consider incorporating GACC products which support long-term decisions at the local unit level.

E. Pocket Cards

The role and responsibilities of PocketCard developers should be included in the FDOP to ensure content and currency of each card is maintained. Coordination and collaboration amongst all affected agencies are essential to ensure consistency; the goal should be to produce one card per FDRA that all agencies would use. Once completed, the PocketCard should be posted on the National Wildfire Coordinating Group website for others to access. Additional PocketCard resources are located on the *FAM-IT Portal*.

F. Seasonal Trend Analysis

The seasonal trend of each selected indicator is graphically compared to normal and all-time worst (for the historical period analyzed) and updated regularly to be posted in dispatch and crew areas. It's recommended that seasonal trends are compared to PocketCard and/or fire danger seasonal graphs intended to inform and educate firefighters on local conditions. PocketCards and seasonal fire danger graphs should use the same index and fuel model to display information so that the two can be easily compared. Seasonal trends pertaining to fuel loading and live fuel moisture should augment NFDRS indices/components for a more comprehensive assessment of the fire season potential.

***BLM –** FA IM-2018-022 describes BLM required criteria for a Seasonal Trend Analysis.*

III. FIRES ANALYSIS (THINGS TO CONSIDER)

The ability to statistically correlate fire danger rating with the probability of fire occurrence is a powerful tool. By knowing the fire danger rating today or the near-future, we can make preparedness decisions based upon the science and technology of NFDRS2016 to calculate the probability of a Fire-Day, Large-Fire-Day, or Multiple-Fire-Day. Before beginning a fires analysis, consider the following:

A. Fire Environment Homogeneity

One of the underlying assumptions of the *Fires Analysis* is that the data represents a relatively homogenous fire environment. Recall that Fire Danger Rating Areas (FDRAs) were delineated to represent the homogeneity of the fire environment; subsequently, the FDRA becomes the basic geographic footprint upon which operational decision support will be built upon. Mixing data between FDRAs invalidates the assumption that climate, topography, and vegetation are relatively similar. Therefore, a separate Fires Analysis must be run for each FDRA.

B. FireFamilyPlus Working Set

The FireFamilyPlus working set defines the characteristics of the FDRA in terms of topography, climate, and vegetation.

1. Fire Danger Rating Areas

   Each FDRA should be analyzed separately by using a fire occurrence dataset which includes only fires that located within the FDRA. Only weather data from the stations previously determined to represent the fire weather network for the respective FDRA should be included.

2. Special Interest Groups (SIGs)

   It can be advantageous to create a SIG comprising several stations within the FDRA to ensure the weather of the area is properly captured

   a. Data Years should be the same for each station in the analysis.

   b. The Fuel Model and Slope Class should be the same for each station in the analysis. Other variables may be different.

   c. Weighting

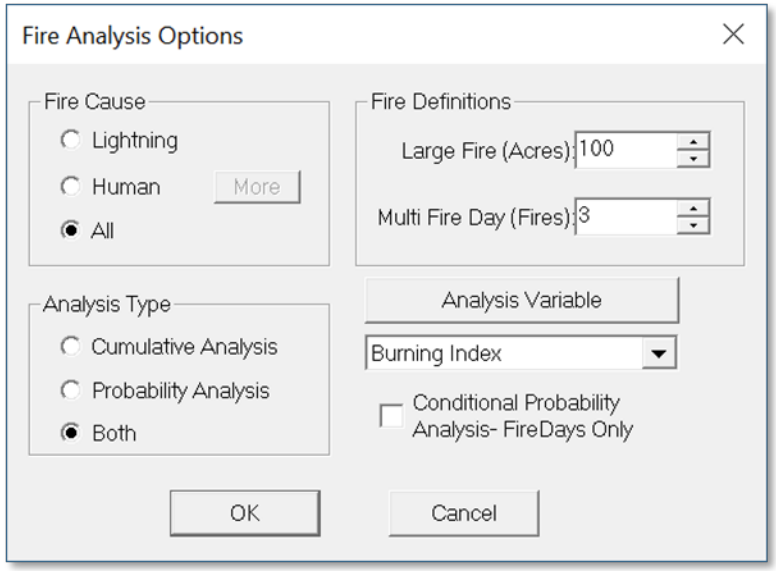
      Weight factors are relative in FireFamilyPlus. Initially, every station in the SIG is assigned a Weight Factor of 1.0, denoting equal weight for all stations. To increase a station's weight for analysis, increase its weight.

      In WIMS, the Weight Factor is a percentage. By default, each station is set to an equal weighting with all other stations in the SIG. WIMS must be set to match the final FFP analysis once the FDOP is completed.

      Generally, weighting RAWS within a SIG is discouraged since it complicates the operations involved with calculating of a weighted average using the NFDRS and results in very little (if any) benefit.

C. Fire Analysis Options

   Upon clicking the Fires Analysis button, the Fire Analysis Options dialog box appears. This dialog box is important, as it will filter the fire occurrence data available for analysis.



1. Fire Cause

   In most cases, we would want to include both Lightning and Human caused fires in our analysis. Usually, we are concerned about the fire danger conditions which result in large or multiple fires – regardless of the cause. In addition, by clipping fire occurrence to Fire Danger Rating Areas, the proportion of lightning-caused to human-caused fires in any given FDRA is resolved.

   However, there may be reasons for excluding lightning or human-caused fires in the analysis if our resulting decisions and actions will be focused solely on fires caused by either lightning or humans, but not both. If either lightning or human-caused fires would be unrepresentative of the target group, the results could be subject to selection bias.

2. Fire Definitions

   Values for these definitions are based on local experience and results from using the fire occurrence summary statistics. Each Fire Danger Rating Area (FDRA) should be considered independently of each other.

   a. **Large Fire** (# of acres) – typically, this would be the acreage that would exceed the capability of the local unit to contain the fire during initial or extended attack. In addition, agency land management planning and policy documents may contain information pertaining to control objectives.

> ***CAUTION***: Overconfidence is one of the largest and most ubiquitous of the many biases to which human judgment is vulnerable. For example, 93 percent of American drivers claim to be better than the median (Svenson, 1981), which is statistically impossible (Steen, 2004). Keep this in mind when determining Large and Multi-Fire values.

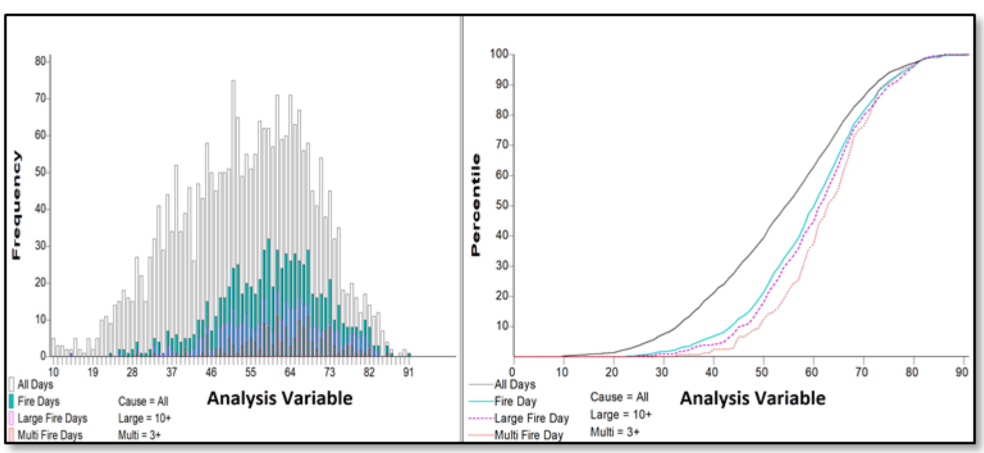
b. **Multi-Fire Day** (# of fires) – typically, this would be the number of fires occurring in a single day that would exceed the capability of the local unit to contain each fire during initial attack.

> ***CAUTION***: Do not manipulate Large Fire or Multi Fire Day values to obtain better statistical correlation. Before conducting the analysis, decide what range of values would be acceptable based upon local experience and the fire occurrence summary statistics.

3. Analysis Type

Typically, ***Both*** are selected to include the *Cumulative Analysis* and *Probability Analysis*. However, the *Probability Analysis* must be selected to proceed with the *Fires Analysis*.

a. **Cumulative Analysis** – Selecting the Cumulative Analysis will display two panels. The left panel will show frequencies as stacked histograms (absolute frequencies). The right panel will show a cumulative frequency distribution curve (percentiles). These charts can provide meaningful visual insight to the chosen Analysis Variable.



b. ***Probability Analysis* –** FireFamilyPlus will create a mathematical model that relates the ***Analysis Variable*** (such as BI, IC, ERC, SC, or KBDI) to a target binary variable. The binary variable has only two possible values (in this case, yes/no) to obtain the estimated probability for each of the two possible responses of the target variable (Fire-Day, Large-Fire-Day, or Multiple-Fire-Day).

- Was this day a *Fire-day*? (yes/no)
- Was this day a *Large Fire-Day*? (yes/no)
- Was this day a *Multiple Fire-Day*? (yes/no)

FireFamilyPlus will derive three probability equations (models) to answer the question: "Under a given set of [*fire environment*] conditions, what is the probability of experiencing a . . .

- ✓ Fire-Day,
- ✓ Large-Fire-Day, and
- ✓ Multiple-Fire-Day?

4. Analysis Variable

A dropdown menu provides options available to select as an analysis variable. When choosing an Analysis Variable, it is important to consider the sensitivity and intended meaning as it relates to the associated Target Group(s).

The determination of the analysis variable is going to depend upon the desired sensitivity which is appropriate for the Target Group and the statistical correlation of a fuel model and the analysis variable.

5. Conditional Probability Analysis

The checkbox controls the sample size of the large, and multiple fire day analysis. If the box is unchecked, all days are included in the large and multiple fire day analysis. If the box is checked, a conditional probability analysis is created where only weather days with fires are included in the large and multiple fire day analysis probability. In most cases, we will be interested in a statistical correlation for all weather days – with the box unchecked – for preparedness decisions which focus primarily on the probability of a fire-day (such as Preparedness, Staffing, and Adjective Fire Danger Rating Levels). However, Response Level decisions are typically based on a reported wildfire and focus primarily on the probability of a large fire. Therefore, it makes sense that Response Level decisions are based upon the condition that a fire-day has already occurred – and the box would be checked.

IV. CHARACTERIZING TARGET GROUPS AND NFDRS FUEL MODELS

Our goal is to match the characteristics of the NFDRS2016 output values to the characteristics of Target Groups. We do this by understanding the sensitivity to the five fuel models in combination with NFDRS output and fuel model with similar characteristics to the Target Group. More specifically, this is with respect to the Target Group's ability to respond, react, and ultimately change their behavior in concert with changes to the NFDRS output values. For example, it may not be best to use Burning Index with Fuel Model V for determining Adjective Fire Danger Rating Levels intended to determine the signs posted on major roadways if we intend to make recreationists aware of the current fire danger rating; in this example, the fire danger rating would change very frequently. If we intend to change the public's awareness, we need to deliver a consistent message which incorporates a future trend for the day (for picnickers), or for several days (for the back-country campers). In addition, consider the workload associated with changing adjective rating level signs. A better option might be Energy Release Component with Fuel Model Y or Z which provides a more stable value with long-term trends which match the public's ability to respond to the fire danger rating.

A. Sensitivity

When developing models, a common consideration is the relative impact of a variable on the output value under a given set of assumptions ─ this is called sensitivity analysis.

There are several perspectives and methods to evaluate model sensitivity, but we are going to simplify that process by focusing on the variables which matter most as it relates to fire danger rating.

B. Characterization of Target Groups

Recall the characteristics of Target Groups as it relates to these characteristics (from Lesson #9 / Task #3):

1. Frame the Fire Issues:

    a. Drilling down to the root of the fire management issue(s) helps us understand the problems, and ultimately the solution(s).

    b. The more specific we can get with respect to the source of the workload, the more specific we can be with fire danger rating to support our decisions.

    c. The Fire Workload Analysis Table in the FDOP Template (Section III.B) is intended to illustrate the framing of fire occurrence workload/issue with specific entities.

2. Generalize the Agency's ability to communicate with the Target Group.

a. In general, Target Groups respond differently to fire danger messages/information.

b. Understanding those differences enhances the Agency's ability to change the behavior or actions of the Target Group.

c. The Decision Summary Table in the FDOP Template (Section III.C) is intended to illustrate a method to associate the characteristics of Target Groups with fire danger rating decision-support tools.

3. Standardize the application of Fire Danger Rating Levels/Plans to Target Groups.

   a. Different applications of Fire Danger Rating Levels/Plans result in confusing from unit to unit.

   b. For example, some units use the Preparedness Level (which may be incorporated in a Preparedness Plan) for decisions affecting the Public or Industry. To be consistent with National and Geographic Areas, the application of Preparedness Levels should affect Agency decisions.

   c. By standardizing, we can consolidate the types of decisions we make affecting Target Groups. For example, the Public Target Group is characterized as slow to respond to changes in fire danger; therefore, it makes sense to incorporate a fuel model and NFDRS index/component combination that is relatively stable and provides a reasonable fire danger rating for several days in the future. The premise is that we cannot expect the Public to react to a volatile fire danger rating.

V. SUMMARY

The logistic regression tool in FireFamilyPlus creates a model that relates an "Analysis Variable" to a target binary variable that has only two possible values (yes/no) to obtain the estimated probability for each of two possible responses for the target variable.

In other words, we can select an NFDRS2016 Fuel Model and an "Analysis Variable" (such as BI, IC, ERC, SC, or KBDI) and run a FireFamilyPlus Fires Analysis which will derive probability equations (models) for Fire-Day, Large-Fire-Day, and Multiple-Fire-Day. We should choose a Fuel Model and Analysis Variable with characteristics which reflect the affected Target Group's ability to react to a corresponding change in Fire Danger.

Discussion Questions:

A. Which correlation of fuel model and NFDRS output is appropriate for a fire response plan?

B. Which correlation of fuel model and NFDRS output is appropriate for a staffing plan with 5 decision classes?

C. Which correlation of fuel model and NFDRS output is appropriate for communication with our internal agency personnel affecting weekly, monthly, or seasonal fire preparedness decisions?

REVIEW OBJECTIVE(S)

Upon completion of this lesson, participants will be able to:

1. Determine which correlation of fuel model and NFDRS output is appropriate for a fire response plan (i.e., pre-planned dispatch, pre-attack plan, run cards).
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